PALISADES SUBBASIN ASSESSMENT AND TOTAL MAXIMUM DAILY LOAD ALLOCATIONS

Antelope Creek Dam 10/2/2000 D. Sharp

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EXECUTIVE SUMMARY

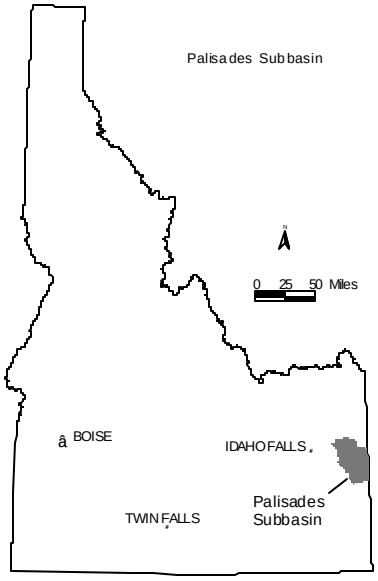
Palisades subbasin drains to the South Fork Snake River in eastern Idaho. Public lands, predominantly forested, cover over two-thirds of the subbasin. The private lands are mainly rural properties used for agriculture. Impaired water quality in Palisades subbasin is mainly caused by deposition of excess fine sediment. Elevated sediment levels in Palisades subbasin are generally caused by recreation, roadways, and livestock grazing in riparian areas. See summary of Palisades subbasin on page 2.

Section 303(d) of the Clean Water Act directs each state to make a list of streams that cannot meet water quality standards. The subbasin assessment process has refined the existing 303(d) list by identifying unknown pollutants; targeting the streams that need load allocations for reduction of sediment; deferring development of load allocations; and removing streams from the list which have insufficient flow to support beneficial uses or that have no management issues related to water quality. Changes to the 1998 303(d) list include the following:

- **Antelope Creek**--For sediment, the upper boundary is extended to Forest Service road culvert and runs to the private dam. From private dam to South Fork Snake River, pollutant is flow alteration. No load allocation will be calculated for flow alteration. A load allocation is calculated for sediment. See complete summary on page 3.
- **Bear Creek**--Bear Creek had been listed from its headwaters to North Fork Bear Creek for an unknown pollutant. The lower boundary is extended to South Fork Snake River. The pollutant has been identified as sediment and a load allocation is calculated. See complete summary on page 4.
- **Camp Creek**-- Camp Creek is listed from its headwaters to Fall Creek for an unknown pollutant. The Camp Creek TMDL will be deferred until the year 2006. See complete summary on page 5.
- **Elk Creek**-- Elk Creek had been listed from its headwaters to West Fork Elk Creek for an unknown pollutant. There are no known human activities impacting the drainage. With no management issues in the riparian areas, Elk Creek will be removed from the 303(d) list. See complete summary on page 6.
- **Fall Creek**-- Fall Creek had been listed from its headwaters to South Fork Fall Creek for an unknown pollutant. Water quality and fish habitat along the unlisted segment of Fall Creek is impacted by grazing and recreational land use. The entire length of Fall Creek will be listed and a TMDL will be calculated in 2006. See complete summary on page 7.
- **Little Elk Creek**-- Little Elk Creek had been listed from its headwaters to Palisades Reservoir for an unknown pollutant. Little Elk Creek cannot support salmonid spawning since the creek is only 2-3" deep with no fish passage. The upper portion is intermittent. Historic high water erosion events have scoured the channel and left the streambed entirely composed of boulder substrate. With a naturally erosive hydrologic condition without observed human impacts, Little Elk Creek will be removed from the 303(d) list. See complete summary on page 8.
- **North Fork Indian Creek**-- North Fork Indian Creek had been listed from the Wyoming State line to Indian Creek. There are no observable human impacts to the riparian area, and no visible fish habitat. Historic high water events have scoured the channel down to bedrock. The stream is subterranean in the lower reach. North Fork Indian Creek will be removed from the 303(d) list. See complete summary on page 9.
- **Sheep Creek**-- Sheep Creek had been listed from its headwaters to South Fork Snake River for an unknown pollutant. Streamflow does not reach one cubic feet per second even in May during spring runoff, so water quality standards do not apply. The Sheep Creek drainage cannot support salmonid spawning since the creek is 4" wide with no fish passage. Sheep Creek will be removed from the 303(d)

list. See complete summary on page 10.

PALISADES SUBBASIN



Hydrologic Unit Code	17040104
Subbasin Drainage size	839.7 mi^2 in Idaho
Total stream miles	1368
Listed stream miles	94.2
Applicable Water Quality Standards	▪ IDAPA 58.01.02.200-General Surface Water Quality Criteria ▪ IDAPA 58.01.02.250-Surface Water Quality Criteria for Aquatic Life Use Designations
Beneficial Uses Affected	▪ Cold water biota ▪ Salmonid spawning
Species of Concern	Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri)*
Public participation	11/10/2000 – 12/10/2000 Five agencies responded

IDEQ 1998 303(d) List
Palisades Subbasin Hydrological Unit Code # 17040104

Waterbody	Boundaries	Year of TMDL	Pollutants		Stream Miles
Antelope Creek	State land boundary to South Fork Snake River	2000	Sediment		11.49
Bear Creek	Headwaters to North Fork Bear Creek	2006		Unknown	12.02
Camp Creek	Headwaters to Fall Creek	2006		Unknown	4.57
Elk Creek	Headwaters to West Fork Elk Creek	2006		Unknown	3.28
Fall Creek	Headwaters to South Fork Fall Creek	2006		Unknown	12.18
Little Elk Creek	Headwaters to Palisades Reservoir	2006		Unknown	4.52
North Fork Indian Creek	Wyoming line to Indian Creek	2006		Unknown	1.08
Snake River	Palisades Dam to Irwin	2000	Flow Alteration		7.28
Snake River	Irwin to HUC Boundary	2000	Flow Alteration		32.41
Sheep Creek	Headwaters to South Fork Snake River	2006		Unknown	5.37

ANTELOPE CREEK

1998 303(d) listed stream miles	11.49
Geomorphic characteristics	▪ Second order stream ▪ Rosgen B channel type
Salmonid spawning	3 age classes including juveniles of yellowstone cutthroat trout
Cold water biota	Macroinvertebrate index scores 3.79 at upper site = not impaired and 0.75 at lower site = impaired
Impacts to riparian area	▪ Private dam intercepting all streamflow ▪ Grazing

Listing history

- 1992 Stream Segment of Concern
- 1998 303(d) listed for sediment

Waterbody Assessment Results

- BURP
  - 1994SIDFA013 MBI 3.79, 38% surface fines, 20.5 w/d ratio
  - 1994SIDFA005 MBI 0.75, 70% surface fines, 4.3 w/d ratio
- State agricultural water quality program assessments
  - Antelope-Pine Creek water quality monitoring suspended sediments at Antelope Creek at 283 mg/l
- IDEQ 2000
  - McNeil sediment core sampling = 46% depth fines
  - Streambank erosion inventory = 82 tons/mile/year with 62% stable banks

Pollutant source inventory

- Idaho agricultural pollution abatement plan targeted non-irrigated cropland as a critical nonpoint source of water pollution due to the highly erodible character of the soils in the Antelope Creek drainage.

Pollution control efforts

- 75% of private lands adjoining Antelope Creek are under contract for best management. Two-thirds of that land has fully implemented prescribed pollution control techniques.

Recommendations and Conclusions

- For sediment, the upper boundary is extended to Forest Service road culvert and runs to the private dam. From private dam to South Fork Snake River, pollutant is flow alteration. No load allocation will be calculated for flow alteration.

Total Maximum Daily Load (TMDL)

A TMDL is the sum of wasteload allocations for point sources and load allocations for nonpoint sources plus a margin of safety:

TMDL = Loading capacity (LC) = ÓWLA + ÓLA + MOS

WLA = 0. Antelope Creek has no point sources contributing pollutants to the stream.

LA = 67.7 tons per year sediment load reduction. The Antelope Creek sediment load is presently 82 tons per mile per year and the streambanks are 62% stable. The chronic sediment load should be reduced by 83% through increased streambank stability.

TARGET = 80% streambank stability and 28% depth fines substrate sediment load

MOS = A margin of safety is implicit through the analytical assumptions made in setting the 80% bank stability and the 28% depth fines targets.

SEASONAL VARIATION = The sediment loads are calculated using long-term average annual rates, which accounts for streambank recession during seasonal and annual variations**.**

BEAR CREEK

1998 303(d) listed stream miles	12.02
Geomorphic characteristics	▪ Second order stream ▪ Rosgen B channel type
Salmonid spawning	1 age class of yellowstone cutthroat trout
Cold water biota	Macroinvertebrate index scores 2.21 at upper site = impaired and 5.13 at lower site = not impaired
Impacts to riparian area	▪ Historical and current grazing ▪ Recreation

Listing history

- Bear Creek was placed on the State of Idaho 303(d) list in 1998 due to a low macroinvertebrate biotic index score at one site.

Waterbody Assessment Results

- BURP
  - 1996SIDFY015 MBI 2.21, 64% surface fines, 8.5 w/d ratio
  - 1996SIDFY031 MBI 5.13, 19% surface fines, 32.3 w/d ratio
- IDEQ 2000
  - McNeil sediment core sampling = 33% depth fines
  - Streambank erosion inventory = 790 tons/mile/year with 68% stable banks

Recommendations and Conclusions

- Bear Creek had been listed from its headwaters to the confluence with North Fork Bear Creek for an unknown pollutant. IDEQ is extending the lower boundary to Bear Creek's confluence with South Fork Snake River. The pollutant has been identified as sediment, for which a load allocation is calculated as follows.

Total Maximum Daily Load (TMDL)

A TMDL is the sum of wasteload allocations for point sources and load allocations for nonpoint sources plus a margin of safety:

TMDL = Loading capacity (LC) = ÓWLA + ÓLA + MOS

WLA = 0. Bear Creek has no point sources contributing pollutants to the stream.

LA = 724.3 tons per year sediment load reduction. The Bear Creek sediment load is presently 790 tons per mile per year and the streambanks are 68% stable. The chronic sediment load should be reduced by 92% through increased streambank stability.

TARGET = 80% streambank stability and 28% depth fines substrate sediment load

MOS = A margin of safety is implicit through the analytical assumptions made in setting the 80% bank stability and the 28% depth fines targets.

SEASONAL VARIATION = The sediment loads are calculated using long-term average annual rates, which accounts for streambank recession during seasonal and annual variations**.**

CAMP CREEK

1998 303(d) listed stream miles	4.57
Geomorphic characteristics	▪ First order stream ▪ Rosgen B channel type
Salmonid spawning	No information
Cold water biota	Macroinvertebrate index score 1.97 = impaired
Impacts to riparian area	Road in floodplain

Listing History

- Camp Creek was placed on the State of Idaho 303(d) list in 1998 due to a low macroinvertebrate biotic index score.

Waterbody Assessments

- BURP
  - 1996SIDFY030 MBI 1.97, 61% surface fines, 12.5 w/d ratio

Recommendations and Conclusions

- Camp Creek is listed from its headwaters to the confluence with Fall Creek for an unknown pollutant. The Camp Creek TMDL will be deferred until the year 2006 to gather more information.

ELK CREEK

1998 303(d) listed stream miles	3.28
Geomorphic characteristics	▪ First order stream ▪ Rosgen A-B channel type
Salmonid spawning	3 age classes including juveniles of yellowstone cutthroat trout
Cold water biota	Macroinvertebrate index score at upper site 1.43 = impaired; Middle site 4.45 = not impaired; Lower site 5.05 = not impaired
Impacts to riparian area	Sediment fans from failed beaver dams in mid-reaches

Listing History

- Elk Creek was placed on the State of Idaho 303(d) list in 1998 due to a low macroinvertebrate biotic index score at one site.

Waterbody Assessments

- BURP
  - 1996SIDFY011 MBI 1.43, 54% surface fines, 8.5 w/d ratio
  - 1996SIDFY012 MBI 4.45, 56% surface fines, 16.2 w/d ratio
  - 1996SIDFY013 MBI 5.05, 34% surface fines, 14.4 w/d ratio

Recommendations and Conclusions

- Elk Creek had been listed from its headwaters to West Fork Elk Creek for an unknown pollutant. On further investigation in October 2000, DEQ found the upper BURP site was not representative of the listed section of Elk Creek. At this time Elk Creek is supporting its beneficial uses. There are no known human activities impacting the drainage. With no management issues in the riparian areas, Elk Creek will be removed from the 303(d) list.

FALL CREEK

1998 303(d) listed stream miles	12.18
Geomorphic characteristics	▪ Second order stream ▪ Rosgen C channel type
Salmonid spawning	2 age classes including juveniles of yellowstone cutthroat trout 3 age classes including juveniles of brook trout
Cold water biota	Macroinvertebrate index score at upper site 1.89 = impaired; Middle site 2.85 = needs verification; Lower site 5.10 = not impaired
Impacts to riparian area	▪ Grazing ▪ Recreational land use

Listing History

- Fall Creek was placed on the State of Idaho 303(d) list in 1998 due to a low macroinvertebrate biotic index score at one site.

Waterbody Assessments

- BURP
  - 1996SIDFY014 MBI 1.89, 60% surface fines, 18.9 w/d ratio
  - 1996SIDFY017 MBI 2.85, 53% surface fines, 9.7 w/d ratio
  - 1996SIDFY032 MBI 5.10, 36% surface fines, 10.9 w/d ratio

Recommendations and Conclusions

- Fall Creek had been listed from its headwaters to South Fork Fall Creek for an unknown pollutant. Water quality and fish habitat along the unlisted segment of Fall Creek is impacted by grazing and recreational land use. The entire length of Fall Creek will be listed and a TMDL will be calculated in 2006.

LITTLE ELK CREEK

1998 303(d) listed stream miles	4.52
Geomorphic characteristics	▪ First order stream ▪ Rosgen A channel type
Salmonid spawning	No information
Cold water biota	Macroinvertebrate index score at upper site 1.54 = impaired; Lower site 2.60 = needs verification
Impacts to riparian area	None observed

Listing History

- Little Elk Creek was placed on the State of Idaho 303(d) list in 1998 due to one low macroinvertebrate biotic index score and one score that needs verification.

Waterbody Assessments

- BURP
  - 1996SIDFZ009 MBI 1.54, 61% surface fines, 23.1 w/d ratio
  - 1996SIDFZ004 MBI 2.60, 75% surface fines, 5.8 w/d ratio

Recommendations and Conclusions

- Little Elk Creek had been listed from its headwaters to Palisades Reservoir for an unknown pollutant. Little Elk Creek cannot support salmonid spawning since the creek is only 2-3" deep with no fish passage. The upper portion is intermittent. Historic high water erosion events have scoured the channel and left the streambed entirely composed of boulder substrate. With a naturally erosive hydrologic condition without observed human impacts, Little Elk Creek will be removed from the 303(d) list.

NORTH FORK INDIAN CREEK

1998 303(d) listed stream miles	1.08
Geomorphic characteristics	▪ First order stream ▪ Rosgen B channel type
Salmonid spawning	No fish observed
Cold water biota	Macroinvertebrate index score 2.35 = impaired
Impacts to riparian area	None observed

Listing History

- North Fork Indian Creek was placed on the State of Idaho 303(d) list in 1998 due to a low macroinvertebrate biotic index score.

Waterbody Assessments

- BURP
  - 1996SIDFZ007 MBI 2.35, 46% surface fines, 8.1 w/d ratio

Recommendations and Conclusions

- North Fork Indian Creek had been listed from the Wyoming State line to Indian Creek. There are no observable human impacts to the riparian area, and no visible fish habitat. Historic high water events have scoured the channel down to bedrock. The stream is subterranean in the lower reach. North Fork Indian Creek will be removed from the 303(d) list.

SHEEP CREEK

1998 303(d) listed stream miles	5.37
Geomorphic characteristics	▪ Second order stream ▪ Rosgen B channel type
Salmonid spawning	No information
Cold water biota	Macroinvertebrate index score at upper site 3.62 = not impaired; Lower site 3.12 = needs verification
Impacts to riparian area	▪ Flow alteration ▪ Grazing ▪ Recreation

Listing History

- Sheep Creek was placed on the State of Idaho 303(d) list in 1998 due to one macroinvertebrate biotic index score that needs verification

Waterbody Assessments

- BURP
  - 1996SIDFZ008 MBI 3.62, 96% surface fines, 8.3 w/d ratio
  - 1996SIDFZ005 MBI 3.12, 98% surface fines, 2.7 w/d ratio

Recommendations and Conclusions

- Sheep Creek had been listed from its headwaters to South Fork Snake River for an unknown pollutant. Streamflow does not reach one cubic feet per second even in May during spring runoff, so water quality standards do not apply. Sheep Creek will be removed from the 303(d) list.

PALISADES SUBBASIN ASSESSMENT

CHARACTERIZATION OF THE SUBBASIN

The Palisades subbasin is located midway down the Idaho-Wyoming border. Approximately ten percent of the subbasin is in Wyoming. The subbasin contains a total area of 927.4 square miles, with 839.7 square miles in Idaho and 87.7 square miles in Wyoming. This area incorporates 1368 stream miles in Idaho and 110 stream miles in Wyoming. The Palisades subbasin is designated as the United States Geological Survey (USGS) cataloging unit hydrological unit code (HUC) number 17040104 (**see Figure 1**). The Idaho portion of HUC 17040104 will be addressed in this assessment. The Palisades subbasin is comprised of the drainage and tributaries of the South Fork Snake River from Palisades Reservoir at the southeast corner of the watershed, through the small communities of Irwin and Swan Valley, to the Heise gaging station. Palisades subbasin is bounded to the south by the Caribou Range, culminating with Caribou Mountain at 9,803 feet. The northern boundary extends to the Big Hole Mountains in the Snake River Range. The northeast boundary runs along the Teton County-Bonneville County border. Elevations in the subbasin range from a minimum of 5,276 feet in Swan Valley, to a maximum elevation of 10,026 feet at Mount Baird (USGS 1996).

Climate Description

The climate of the Palisades subbasin is semiarid with cool, moist winters and warm, dry summers. Air masses from the Pacific Ocean, Gulf of Mexico and central Canada affecting the region are tempered by the strong topographical relief of the Rocky Mountains. In winter, prevailing western winds deposit most of the annual moisture in the form of snow from late October through early May. The mountains partially shield the region from extremely cold, dry arctic winds. Winters are cold, but not generally severe (Rupert 1994). During summer months, western winds are weaker and partially blocked from bringing precipitation into lower elevations of the subbasin, leaving rainfall, cloud cover and humidity at a minimum. Continental conditions predominate during summer, with sporadic thunderstorms from subtropical oceanic airflow (Abramovich and others 1998). Average maximum and minimum temperatures and precipitation for two weather stations in the Palisades subbasin are presented in Tables 1 and 2.

Maximum monthly temperatures climb to the low 80s (^{N}F) on average during summer months with the highest maximum temperatures occurring in July and August, while minimum temperatures can drop as low as 10 ^{N}F in the winter (See Table 1). The annual average maximum temperature is 56.3 ^{N}F and the annual average minimum temperature is 29.2 ^{N}F for the region. In lower elevations, the growing season generally ranges from mid-May to the first of October. In higher elevations, probable frost-free dates range from the first of June to early or mid-September, sometimes even limiting the growing season to as few as 60 days in the coldest years (Western Regional Climate Center 2000).

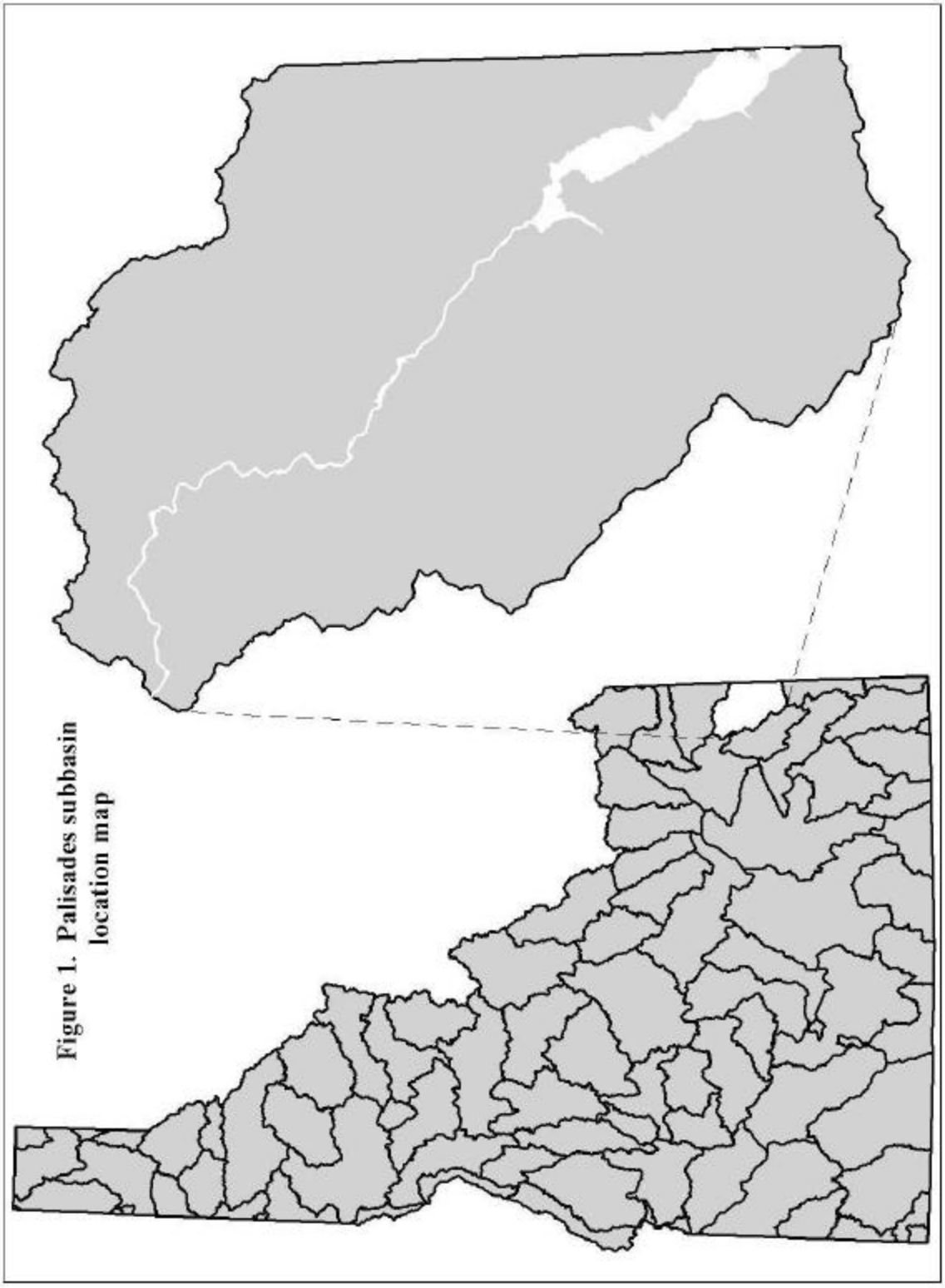


Figure 1. Palisades subbasin location map

Table 1. Summary of temperature data collected from 7/8/1947 to 8/31/1993 at Palisades and 7/8/1960 to 12/31/1999 at Swan Valley.

Period	Average Maximum Temperature °F		Average Minimum Temperature °F	
	Palisades	Swan Valley	Palisades	Swan Valley
January	29.0	30.0	11.8	10.2
February	34.2	35.9	14.3	13.0
March	42.1	44.0	19.9	20.6
April	53.9	54.6	29.0	27.4
May	65.4	65.0	37.5	34.5
June	74.7	74.6	44.3	40.3
July	84.0	84.1	50.8	44.6
August	82.1	83.1	49.1	43.4
September	73.1	73.5	41.0	36.0
October	60.2	60.3	32.6	27.4
November	42.4	42.4	23.9	21.0
December	31.5	31.3	15.9	11.8
Annual	56.0	56.6	30.8	27.5

Source: Western Regional Climate Center at http://www.wrcc.dri.edu/summary/climsmid.html

Table 2. Summary of precipitation data collected from Palisades and Swan Valley.

Period	Average Total Precipitation (in.)		Average Total Snowfall (in.)	
	Palisades	Swan Valley	Palisades	Swan Valley
January	1.94	1.54	21.0	17.0
February	1.63	1.06	14.8	8.9
March	1.52	1.21	11.0	7.5
April	1.56	1.58	3.5	3.8
May	2.16	2.57	0.5	1.1
June	1.94	1.68	0.0	0.1
July	1.12	1.30	0.0	0.0
August	1.29	1.29	0.0	0.0
September	1.49	1.53	0.0	0.2
October	1.37	1.25	1.0	0.9
November	1.76	1.56	7.3	7.2
December	1.94	1.30	17.7	12.4
Annual	19.72	17.87	76.9	59.0

Source: Western Regional Climate Center at http://www.wrcc.dri.edu/summary/climsmid.html

Total annual precipitation averages 19.72 inches at Palisades weather station and 17.87 inches at Swan Valley (See Table 2). Over 50 percent of the annual precipitation falls in April through September, which is the typical growing season for most regional crops. May has the highest average precipitation. For many cultivated portions of land in the northwestern part of the Palisades subbasin, the cooler part of the year provides adequate precipitation for dryland agriculture. A large proportion of the drainage basin is mountainous and forested, and the runoff pattern is ruled by timing of snowmelt. When the snowpack at higher elevations melts in early to mid-summer, irrigation water is supplied for irrigated crops at lower elevations.

The Soil Conservation Service (SCS) has reported weather information for Bonneville County. Cloud cover is relatively low in the summer, allowing clear skies 80 percent of the time. The sun shines 40 percent of the time in winter. Throughout the year, maximum relative humidity generally corresponds with lowest temperatures. In the summer, relative humidity averages 70 percent at dawn and decreases to 25 to 30 percent by late afternoon. In the winter, early morning humidity of an average 85 percent only drops to 70 to 80 percent by late afternoon (SCS 1981).

Hydrology

The primary drainage for streams and groundwater in the Palisades subbasin is the South Fork Snake River. The US Bureau of Land Management (BLM) and Targhee National Forest (TNF) describe three general sections that characterize the stream corridor of the South Fork in this watershed (BLM and TNF 1991). From Palisades Dam downstream to Squaw Creek, the river follows a single channel through a narrow mountain valley cut into surrounding terraces and rising steeply with an abrupt transition to the uplands. Downstream from Squaw Creek, the river begins showing complex floodplain features with side channels and islands, but the river bottom is narrow, flowing through a rugged canyon. No road or foot traffic is possible along this stretch. The final stretch of the South Fork in this subbasin flows through a narrow canyon, but the river has several large river bars and numerous islands (BLM and TNF 1991).

Management of Palisades Reservoir currently regulates the water level and volume of the South Fork Snake River. Building of Palisades Dam was authorized primarily to store irrigation water, and the reservoir currently maintains an active storage capacity of 1,200,000 acre-feet. Upon completion of the dam in 1956, the upper portion of Swan Valley was inundated and the flow rate of the river has been directed by irrigation needs since reservoir management began in 1957. Palisades Reservoir is also managed for flood control, power generation, recreation and wildlife conservation. Water supply and demand is affected not only by weather, but also by storage holdover and water rights, so analysis of average annual streamflow will not indicate natural hydrological trends for the South Fork (BLM and TNF 1990).

Tributary flows are not regulated. The mountainous character of most of the drainage contributes to the natural stream discharge. The runoff pattern is dominated by snowmelt, which contributes to daily as

well as seasonal variations in stream flow measurements. Flows are usually highest during spring runoff. Occasional summer thunderstorms sometimes increase tributary stream flow, but generally the lowest flows are in summer, fall, and winter (Drewes 1991).

Composite hydrographs of mean daily discharge of the South Fork at the Heise gaging station in Merigliano (1996) compare pre-Palisades Dam years to post-dam years to demonstrate altered flow patterns. After the dam began controlling water discharge in 1957, three significant flow alteration trends appear on the comparative hydrographs. First, comparatively more water is released earlier in the spring prior to snowmelt runoff in post-dam years. Throughout the late spring and summer months, larger peak flows that could lead to flooding are reduced. Finally, flows lower than pre-Palisades Dam conditions generally occur during fall and winter months while the reservoir is filling. Although the frequency of moderate flows has remained similar to pre-dam data, the timing of these flows has changed. Moderate flows are the most efficient at transporting sediments over time, and the frequency of moderate flows has not changed significantly with operation of the dam.

Eighteen USGS gages are located in the Palisades subbasin (**Figure 2**). The two USGS gages for the longest period of record and the capability for reporting Real Time data are both below the dam on the South Fork Snake River near Irwin and Heise. As shown in Table 3, the average annual discharge for the South Fork near Irwin is 6,578 cfs for the period from 1935 to 1999, while the average annual discharge near Heise is 7,037 cfs for data years 1911-1999. Since Palisades Reservoir is managed primarily for irrigation needs (BLM and TNF 1990), the minor decrease in the lowest annual streamflows at the downstream Heise gage may be due to irrigation withdrawals.

Table 3. Flow Statistics for Data of Record for USGS stations near Heise and Irwin.

Station Name	Station #	Data Years	Average Annual (cfs)	Highest Annual (cfs)	Lowest Annual (cfs)
Snake River near Irwin, ID	13032500	1935-1999	6,578	10,710	4,394
Snake River near Heise, ID	13037500	1911-1999	7,037	11,590	4,117

Source: USGS surface water data at http://idaho.usgs.gov

Drainage patterns are complex, but most of the major streams within Palisades subbasin exhibit dendritic, or branching, drainage patterns (**Figure 3**, USGS 1996), with some parallel drainage patterns in the Fall Creek region.

Geology and Geomorphology

Geological forces created a distinctive topographic trend along a northwest to southeast axis (**Figure 4**, USGS 1992), with mountain ranges to southwest and northeast of the South Fork

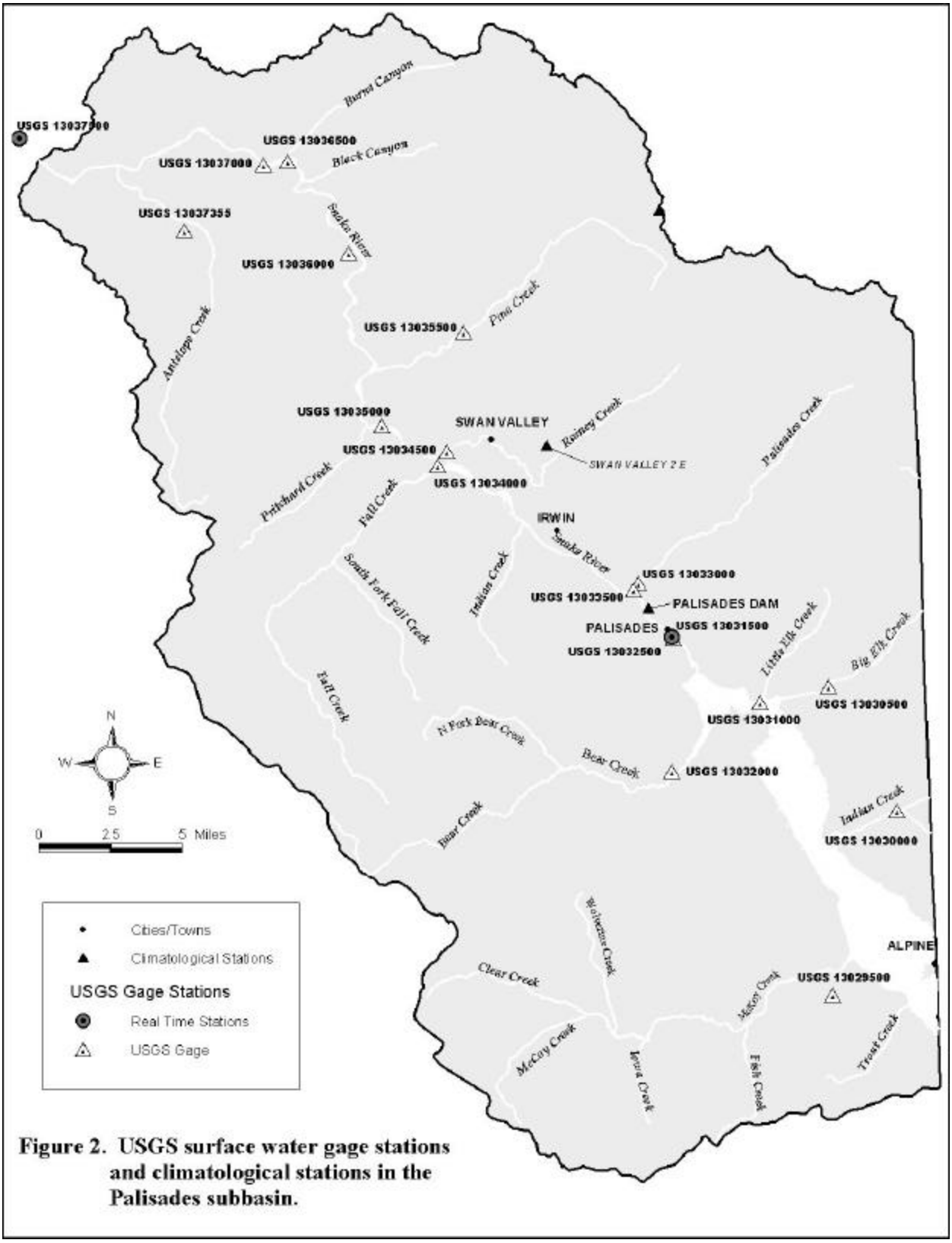


Figure 2. USGS surface water gage stations and climatological stations in the Palisades subbasin.

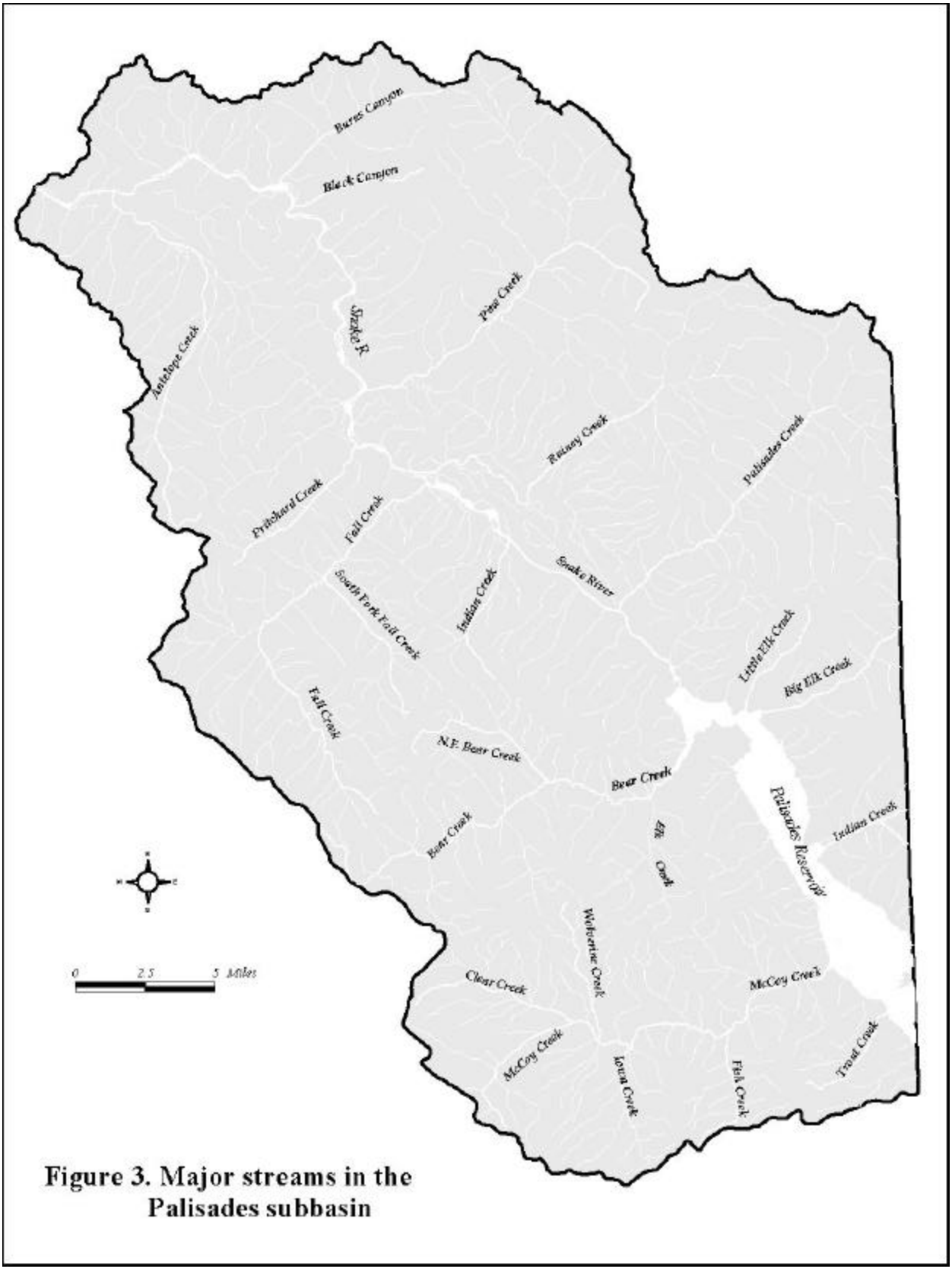


Figure 3. Major streams in the Palisades subbasin

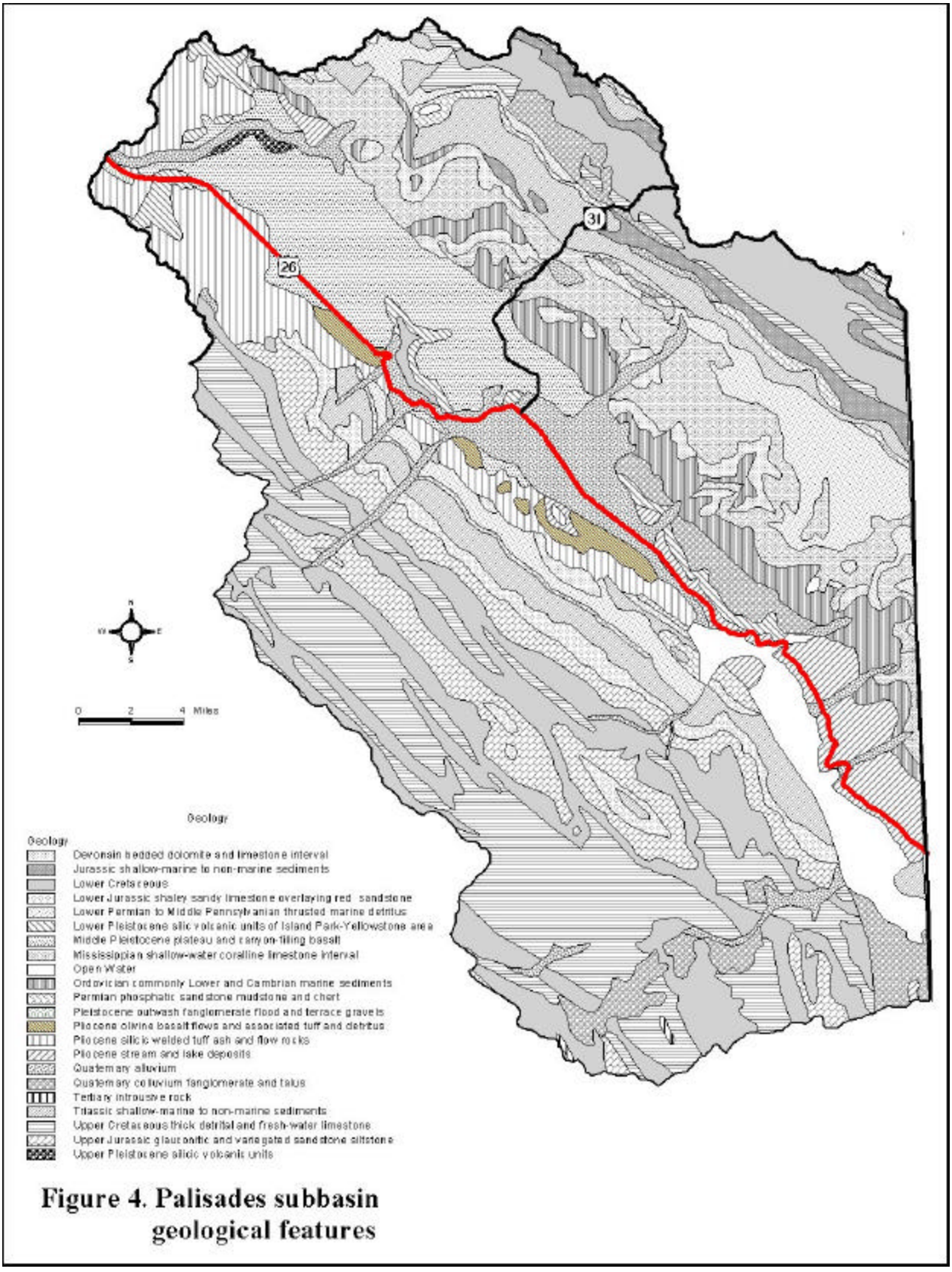


Figure 4. Palisades subbasin geological features

Snake River and valley flats between the ranges. An overthrust belt that was active during formation of the Rocky Mountains pushed from the southwest through layers of sedimentary bedrock to form the Caribou Range. High angle block-faulting events cut into this overthrust belt to create typical Basin and Range topography. These characteristics place the Palisades subbasin in the Middle Rocky Mountains Physiographic Province with block-faulting influence from the Basin and Range Province to the south (Alt and Hyndman 1989).

Volcanic flows cover some of the overthrust structures in the Big Hole Mountains and Snake River Range (Alt and Hyndman 1989). Further geological events that have shaped the region include glacial depositional/erosional cycles and deposits of alluvium at the base of block faults (Merigliano 1996).

Mountains associated with overthrust throughout Caribou Range are composed of hard Mesozoic sedimentary bedrock, mostly limestone, but also with layers of conglomerate, sandstone, siltstone, and shale. The thrust plate has contorted and tightly folded these sedimentary layers until in some places the oldest layer is topmost. The Caribou Range overthrust structure is broken into many valleys, not only by streams eroding less resistant rock, but also by Basin and Range Block faulting that occurred at the same time as the formation of the Snake River plain. Basin and Range faults are normal faults, where the rock is pulled apart, creating structural mountains out of large elongate blocks of the earth=s crust. The crust extension allows numerous lava flows (Maley 1987). Pliocene rhyolitic flows overlay some of the sedimentary layers in the Caribou Range from Swan Valley up through Antelope Flat to Lookout Mountain. Basalt flows can also be found overlapping the base of the Caribou Range (Alt and Hyndman 1989).

To the north and northeast of the South Fork, the Snake River Range shows very old Paleozoic formations and the Big Hole Range contains both Mesozoic and Paleozoic formations. Mountains in both the Big Hole and Snake River Range are also associated with overthrust or Basin and Range structures. The ridgeline mountains exhibit higher relief than those in the Caribou Range, rising 4000 to 6000 feet above the adjacent landscape. Even the foothills and lower mountains rise 500 to 4000 feet above the surrounding terrain. Evidence of repeated glacial episodes is shown in the drainages northeast of the South Fork. The Big Hole and Snake River Ranges exhibit mainly igneous rocks of intermediate hardness. Rhyolite and rhyolitic tuff are the dominant igneous rocks, associated with extrusive flows and dissected shields. The extrusive flows spread over the older Paleozoic and Mesozoic sedimentary overthrust structures of sandstone, shale, limestone and dolomite. Drainage patterns are very complex throughout the Big Hole and Snake River Ranges due to the variable bedrock materials. Springs and creeks are common on the sedimentary substrates and rare on the igneous substrates (TNF 1997a).

The valley flats between the ranges consist predominately of Tertiary valley-fill sediments in Swan Valley and Snake River plain basalt flows downstream through the Antelope Flat region. Swan Valley is a high, narrow valley between steep mountain ranges and was formed by a large fault block with an east-

west trending fault line that is parallel to the valley. Volcanic rocks cover the sides of the valley, while gravelly glacial outwash covers the valley floor. Windblown loess soils have been deposited throughout Swan Valley, especially on the north side (SCS 1994). Downstream from Swan Valley, the course of the South Fork narrows into the steep cliffs of Conant Valley where the south bank shows distinctively warped exposed sedimentary rock. Further downstream, Antelope Flat is a broad, flat floodplain where the river takes a more meandering pattern, continuing to deposit glacial sediments. Interbedded with unconsolidated sediments, the basalt flows generally covering this region are broken and full of cavities, making the rock very permeable to water (TNF 1997b). Although more angular gravel is found in the tributaries, the type of soils that are mostly transported as sediments in the South Fork are rounded cobble from glacial deposits (Merigliano 1996).

Soils are dominated by very deep, well-drained soils with rapid permeability below the surface. Most of the soils are derived from either coarse gravel-cobble glacial outwash or windblown loess deposits. From the small community of Irwin through Swan Valley and all along the South Fork floodplain, the soil types belong in the "Hobacker-Badgerton Variant". These very deep soils exist on floodplains from nearly level to moderately steep slopes from 5,000 to 5,500 feet in elevation. The Hobacker soils comprise the majority of this soil series and have a surface layer of gravelly loam and very gravelly loam, with extremely gravelly sandy loam found at a depth of 30 inches. The loamy sand of Badgerton soils are also common in this complex. Irrigated crops are grown on these floodplain soils. Native vegetation typically includes various sagebrush (*Artemisia* spp.) or antelope bitterbrush (*Purshia tridentata*) communities (SCS 1981).

The ATetonia-Rin-Ririe@ soil series is found in higher elevations, from 5,200 to 7,000 feet, in the drainages of Antelope Creek, Pine Creek and Rainey Creek. Tetonia-Rin-Ririe soils are very deep silt loams and occur on level to very steep slopes. They are well-drained soils found on loess foothills, plateaus and mountainsides. Non-irrigated crops are most productive in these soils, and irrigated crops are common. Depending upon slope, these soils are highly erodible. Native vegetation includes sagebrush communities interspersed with grasses (SCS 1981).

Soils in the Caribou Range and Snake River Range are sloping to very steep, deep and well-drained soils with frequent rock outcropping, in elevations from 5,500 to 9,900 feet. The rangelands and forestlands occurring on these soils support livestock grazing as well as wildlife habitat. Native vegetation ranges from sagebrush community types to Douglas-fir (*Pseudotsuga menziesii)*, Englemann=s spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*) and quaking aspen (*Populus tremuloides*) forests (SCS 1981).

Vegetation

Diverse plant communities populate the Palisades subbasin. Caribou National Forest (CNF) and TNF describe a varied terrain that supports coniferous forests, hardwood forests, shrub rangelands,

grasslands, alpine and riparian communities. The landscape is about 60 percent forested and 40 percent nonforested. Mixed lodgepole pine (*Pinus contorta*) and Douglas-fir are 47 percent of the forest type. Aspen, pure Douglas-fir, or pure lodgepole pine account for about 15 percent of forests each. Rangelands exhibit a variety of vegetation, consisting of mountain brush, sagebrush and grass, or grass and forb meadows. Narrowleaf cottonwood (*Populus angustifolia*) forests extend along the river bottom (TNF 1997a and CNF 1999).

Variability of the vegetation types depends upon the varying soils, elevation, slope and aspect of the subbasin. A range of climatic conditions produced by the variable topography allows a biogeographical range from subalpine meadows to dry shrublands to develop. At the highest altitudes from 6,000 to 10,000 feet, with elevated moisture, cool temperatures and short growing seasons, the subalpine zone is dominated by subalpine fir and Engelmann=s spruce. Lower elevations grade into upland slopes that are still relatively moist and cool where Douglas-fir predominates. After disturbance in subalpine or montane zones, quaking aspen and lodgepole pine pioneer. On areas of mountain brush on drier upland slopes, curlleaf mountain mahogany (*Cercocarpus ledifolius* var. *intercedens*) is found on south slopes, while black chokecherry (*Prunus virginiana* var. *melanocarpa*), Saskatoon serviceberry (*Amelanchier alnifolia*), antelope bitterbrush and Rocky Mountain maple (*Acer glabrum*) are found on various slopes and aspects depending on elevation. On the lowest, driest slopes, various sagebrush communities are interspersed with grass/forb meadows and mountain brush (TNF 1997a and CNF 1999).

Forestlands and rangelands throughout the Palisades subbasin are very limited in age class diversity. As much as 95 to 99 percent of the conifer forests are in a mature age class. While this does provide habitat for a wide variety of interior wildlife species, it can promote hazards for large fires, insect damage and disease problems. Douglas-fir is becoming more predominant as it encroaches on stands of lodgepole pine, aspen and shrubs. Most of the shrublands are also in a late age class, with the same risks of fire, insects and disease (TNF 1997a).

The most significant impact on habitat is from water containment at Palisades Reservoir and management of the streamflow in the South Fork Snake River. Cottonwood forests along the river bottom generate the most extensive cottonwood riparian area remaining in Idaho. The cottonwoods produce a unique habitat with high-density populations of bald eagles and other wildlife. Although presently in good condition, the cottonwoods are nearly all in a mature age class due to a lack of periodic disturbance and flooding necessary for cottonwood regeneration. Historically, disturbance patterns were created by periodic flooding, but flooding has been controlled by Palisades Dam and development within the 100-year floodplain of the South Fork. If reservoir and land management continues under present conditions, then the cottonwood forests will decline (TNF 1997a and Merigliano 1996).

Vegetation growing along the streambanks of tributaries, termed the riparian zone, helps to stabilize the

streambanks. Riparian vegetation in Palisades subbasin commonly consists of various grasses and forbs, willows (*Salix* sp.), red-osier dogwood (*Cornus sericea*), black hawthorn (*Crataegus douglasii*), water birch (*Betula occidentalis*), and Rocky Mountain maple. Overstory species commonly include Douglas-fir, quaking aspen, and lodgepole pine. Physical habitat descriptions by TNF (2000) and IDEQ (1996) detail plant species along tributary streambanks. Willow complexes are the most common plants growing along streambanks, along with grasses and forbs. Riparian communities in the sub-watersheds east of the river consist of more shade-loving species that tolerate wet soils, such as red-osier dogwood, water birch, black hawthorn and various sedges. West of the river, riparian vegetation more frequently includes such drought-tolerant species as rabbit brush (*Chrysothamnus* sp.) and sagebrush. The aspect of the watershed influences the plant species that are present in the riparian zone.

Mid-elevation wetlands on alluvial substrates along the South Fork are home to a globally rare species of orchid called Ute's Ladies Tresses (*Spiranthes diluvialis*), listed as threatened under the Endangered Species Act. Despite inventories of other riparian zones in Idaho, the orchid has only been found distributed in the silverberry (*Elaeagnus commutata*) community type along 49 river miles between the confluence of the Henrys Fork upstream to Swan Valley, nine river miles below Palisades Dam (Moseley 1997). Although Ute's Ladies Tresses is the only rare plant given federal protection, two other globally rare species and ten state rare or sensitive species of plants are in the subbasin (Conservation Data Center 2000 and Idaho Native Plant Society 2000).

Bonneville County, making up the largest part of the Palisades subbasin, is about 70 percent non-forested, with almost 300,000 forested acres (Table 4). Most of the timberland is in public ownership, as shown in Table 5. Table 6 summarizes the main forest types. The forests are three quarters coniferous and one-quarter hardwoods, predominately aspen. Of the conifer forests, Douglas-fir community types make up over half of the stands, with 34 percent being a spruce/Douglas-fir mix and 12 percent lodgepole pine.

Table 4. Land class area (in acres) for Bonneville County.

All Land	Forest Land				Nonforest
	Total	Timberland	Other Forest	Reserved	
1,030,800	297,100	276,400	20,700	0	733,800

Source: FIA Database Retrieval System (www.srsfia.usfs.msstate.edu/scripts/twig); results are rounded

Table 5. Timberland ownership acreage in Bonneville County.

All Owners	National Forest	BLM	State	Farmer/ Rancher	Private Corp.	Private Individual

276,400	219,500	5,300	10,700	31,800	0	9,000

Source: FIA Database Retrieval System (www.srsfia.usfs.msstate.edu/scripts/twig); results are rounded

Table 6. Area (acres) of timberland by forest type and ownership in Bonneville County.

Forest Type	All Owners	National Forest	Other Public	Private
Spruce/Fir	69,400	64,000	5,300	0
Douglas-fir	111,200	111,200	0	0
Lodgepole Pine	24,000	24,000	0	0
Conifer Total	204,500	199,200	5,300	0
Elm/Ash/Cottonwood	5,300	0	5,300	0
Aspen/Birch	61,700	15,500	5,300	40,900
Hardwood Total	67,000	15,500	10,700	40,900
Nontyped	4,900	4,900	0	0
All Types Total	276,400	219,500	16,000	40,900

Source: FIA Database Retrieval System (www.srsfia.usfs.msstate.edu/scripts/twig); results are rounded

Fisheries

The number and variety of fish species in the Palisades subbasin are influenced naturally by Shoshone Falls near Twin Falls, Idaho. Representatives of the sucker family (Catostomidae), sculpin family (Cottidae), minnow family (Cyprinidae), as well as the trout and salmon family (Salmonidae) are known to occur. Suckers reported in the subbasin include the bluehead sucker (*Catostomus discobolus*), mountain sucker (*C. platyrhynchus*), and Utah sucker (*C. ardens*). Sculpins in the subbasin include the mottled sculpin (*Cottus bairdi*) and the Paiute sculpin (*C. beldingi*). Minnows reported in the subbasin include the longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*), speckled dace (*Rhinichthys osculus*), and Utah chub (*Gila atraria*). The leatherside chub (*Gila copei*) is reported from Jackknife Creek, at tributary of the Salt River, which flows into Palisades Reservoir. Leatherside chub could easily occur in the Palisades subbasin as well. Species of the family Salmonidae reported in the subbasin include brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), cutthroat trout (*Oncorhynchus clarki sp.*), mountain whitefish (*Prosopium williamsoni*), rainbow trout (*O. mykiss sp.*), and cutthroat trout-rainbow trout hybrids. These occurrence reports are taken from Lee and others (1980), Simpson and Wallace (1982), Baxter and Stone (1995), Maret (1997), and the data sources listed in Table 7. No bull trout (*Salvelinus confluentus*) are known to occur in the Palisades subbasin.

Yellowstone cutthroat trout (*O. c. bouvieri*) is the species of greatest concern in the Palisades subbasin. May (1996) reports that, in Idaho, only ten percent of the populations of Yellowstone cutthroat trout are secure and stable. In its historic range, the Yellowstone cutthroat trout is estimated to occupy 41 percent of the riverine environments (May 1996). A primary objective of the Idaho Department of Fish and Game (IDFG) is to Apreserve the genetic integrity and population viability of wild native cutthroat trout@ in the South Fork Snake River drainage (IDFG 1996). Stocking of rainbow and brown trout was discontinued in the early 1980s to reduce competition with Yellowstone cutthroat trout.

The IDFG and the U. S. Fish and Wildlife Service (FWS) have rated the fishery resources for a number of water bodies in the Palisades subbasin. The South Fork Snake River below Palisades Dam is rated as a Ahighest-valued@ fishery resource. Bear Creek, Big Elk Creek, Burns Creek, Fall Creek, Palisades Creek, Pine Creek, and Rainey Creek are rated as Ahigh priority@ fishery resources. McCoy Creek and Pritchard Creek are rated as Asubstantial@ fishery resources (IDFG and FWS 1978). Fishing effort on the South Fork Snake River below Palisades Dam was estimated to be 25,000 angler days in 1981 and 22,500 angler hours on Palisades Reservoir in 1993 (IDFG 1996). Streams in the Palisades subbasin known to contain cutthroat trout are shown in **Figure 5**.

Table 7. Occurrence of fish and number of salmonid age classes in the Palisades cataloging unit (17040104).

Water body (WBID # [1])	CTT [2]	BRK [3]	BRN [4]	KOK [5]	LKT [6]	MWF [7]	RBT [8]	Non-salmonids	Comments	Data source
Antelope Creek (2)	2/J									Moore 1981
Antelope Creek (2)	3/J	X							visual estimate	Zaroban and Herron 2000
Antelope Creek (2)	X									TNF 2000
Bear Creek (11)	1							mottled sculpin, Paiute sculpin, speckled dace		IDEQ 1996
Bear Creek (11)	X					X		dace, sculpin, shiners, suckers		TNF 2000
Big Elk Creek (25)	3+/J			X				sculpins, suckers		TNF 1999a
Big Elk Creek (25)	4+			2/J						Moore and others 1981
Big Spring Creek (10)	X							dace, sculpin		TNF 2000
Black Canyon Creek (30)	3/J									Moore 1981
Burns Creek (31)	X								stocked CTT	Moore 1980
Burns Creek (31)	5+/J					X		sculpins		Moore 1981
Burns Creek (31)	4+/J					X		longnose dace, sculpins	stocked CTT	Moore and Schill 1984
Burns Creek (31)	3+/J		1					sculpins	hybrids	TNF 1999a
Burns Creek (31)	X							sculpins		TNF 2000
Clear Creek (18)	X							dace, sculpins, sucker		TNF 2000
Deer Creek (8)									no fish observed	TNF 1999a
Elk Creek (11)	3+/J							Paiute sculpin		IDEQ 1996
Fall Creek (6)	X								stocked RBT	Moore 1980
Fall Creek (6)									stocked RBT	Moore and Schill 1984
Fall Creek (6)	2+/J							dace, sculpins, shiners		Elle and Corsi 1994
Fall Creek (6)	3	3+/J						sculpins, longnose dace, speckled dace		TNF 1999a
Fish Creek (21)	X							sculpins		TNF 2000
Garden Creek (3)	3+/J									TNF 1999
Garden Creek (3)	X									TNF 2000
Gibson Creek (6)	1/J	3								IDEQ 1996

Water body (WBID # [1])	CTT [2]	BRK [3]	BRN [4]	KOK [5]	LKT [6]	MWF [7]	RBT [8]	Non-salmonids	Comments	Data source
Hawley Gulch Creek (1)									no fish observed	IDEQ 1997
Hawley Gulch Creek (1)									no fish observed	TNF 2000
Indian Creek (9)	3+/J									Moore 1980
Indian Creek (9)	4+/J									Moore 1981
Indian Creek (9)	4+/J									Moore and Schill 1984
Indian Creek (9)	2/J									IDEQ 1996
Indian Creek (9)	4+/J						1/J			TNF 1999a
Indian Creek (24)									no fish observed	Moore and others 1981
Indian Creek (24)									no fish observed	TNF 1999a
Landslide Creek (10)	X							Sculpin, hybrids		TNF 2000
McCoy Creek (14)	4+/J		2			3+/J	1	sculpins, mountain sucker, redside shiner	hybrids	TNF 1999a
McCoy Creek (14, 15, 16, 19)	5+									Elle and Corsi 1994
McCoy Creek (15, 19)	X							dace, sculpin, shiners		TNF 2000
Nelson Creek (2)	X									TNF 2000
North Fork Indian Creek (24)		X								TNF 2000
North Fork Pine Creek (29)	3/J							Paiute sculpin		IDEQ 1996
Palisades Creek (27)	X/J									Moore 1980
Palisades Creek (27)	5+/J		X			X	X	longnose dace, sculpin	hybrids	Moore and Schill 1984
Palisades Creek (27)	3+					1+	2	sculpins	hybrids	TNF 1999a
Palisades Reservoir (10)	X				X				stocked CTT, LKT	Moore 1980
Palisades Reservoir (10)	3+		3+	X	3+	X	X			Moore and others 1981
Palisades Reservoir (10)									stocked CTT, LKT	Moore and Schill 1984
Palisades Reservoir (10)	X		X	X	X	X	X		Utah sucker, chubs	Corsi and Elle 1986a
Papoose Creek (8)									no fish observed	TNF 1999a

Water body (WBID # [1])	CTT [2]	BRK [3]	BRN [4]	KOK [5]	LKT [6]	MWF [7]	RBT [8]	Non-salmonids	Comments	Data source
Pine Creek (29)	2+/J						X		stocked RBT	Moore 1980
Pine Creek (29)	3+/J		1/J			3+	X	longnose dace, speckled dace, bluehead sucker, Utah sucker, mottled sculpin, Paiute sculpin		Moore 1981
Pine Creek (29)	5+/J						X	bluehead sucker, longnose dace, speckled dace, sculpin	stocked RBT	Moore and Schill 1984
Pine Creek (29)	3/J							Paiute sculpin		IDEQ 1996
Pine Creek (29)	4/J						3+/J	sculpins, Utah sucker	hybrids	TNF 1999a
Pritchard Creek (4)	X									Moore 1980
Pritchard Creek (4)	4+/J		2+/J			X				Corsi and Elle 1986b
Pritchard Creek (4)	3+/J									TNF 1999a
Rainey Creek (28)	3+/J								stocked CTT, RBT	Moore 1980
Rainey Creek (28)	4+/J					2+/J		suckers, longnose dace, speckled dace, sculpin, redside shiner		Moore 1981
Rainey Creek (28)	4+/J		X					longnose dace, speckled dace, suckers, sculpin, redside shiner	stocked BRN, CTT, RBT	Moore and Schill 1984
Rainey Creek (28)	3/J	2/J						mottled sculpin, Paiute sculpin		IDEQ 1996, 1998
Rainey Creek (28)	4+/J							sculpins		TNF 1999a
Snake River, SF (1)	X		X		X	X	X			Moore 1980
Snake River, SF (1)	X		X		X	X	X		stocked BRN	Moore and Schill 1984
Snake River, SF (1)	5/J		4			4+/J	2	Utah sucker, mottled sculpin, longnose dace, speckled dace	hybrids	Maret 1999
Snake River, SF (3)	X		X		X	X	X			Moore 1980
Snake River, SF (3)	X		X		X	X	X		stocked BRN	Moore and Schill 1984
Snake River, SF (3)	4+/J		4+/J						hybrids	Elle and Gamblin 1993
Snake River, SF (3)	5+/J		X			3+			hybrids	Elle and

Water body (WBID # [1])	CTT [2]	BRK [3]	BRN [4]	KOK [5]	LKT [6]	MWF [7]	RBT [8]	Non-salmonids	Comments	Data source
										Corsi 1994
Snake River, SF (8)	X		X		X	X	X			Moore 1980
Snake River, SF (8)	X		X		X	X	X		stocked BRN	Moore and Schill 1984
Squaw Creek (8)	1									TNF 1999a
Sulphur Bar Creek (10)	X							dace, sculpin		TNF 2000
Table Rock Creek (1)									no fish observed	Moore 1980
Table Rock Creek (1)	3									Moore 1981
Table Rock Creek (1)	X									TNF 2000
Tie Canyon Creek (29)	2							Paiute sculpin		IDEQ 1996
Trout Creek (22)	4+/J	1/J	1/J				1/J			Moore and others 1981
West Pine Creek (29)	1							Paiute sculpin	hybrids	IDEQ 1996
Williams Creek (10)	X		X							TNF 2000
Wolverine Creek (1)	2+/J									Moore 1981
Wolverine Creek (1)	X									TNF 2000
Yeaman Creek (8)									stocked RBT	Moore 1980
Yeaman Creek (8)									stocked RBT	Moore and Schill 1984
Yeaman Creek (8)									no fish observed	TNF 1999a

[1]WBID#: Idaho Department of Environmental Quality water body index number as listed in IDAPA 58.01.02.150.01.
[2]CTT: cutthroat trout
[3]BRK: brook trout
[4]BRN: brown trout
[5]KOK: kokanee
[6]LKT: lake trout
[7]MWF: mountain whitefish
[8]RBT: rainbow trout
J: age classes present include juveniles
X: species reported present, no indication of number of age classes observed
+: number provided in table is a conservative estimate of age classes present

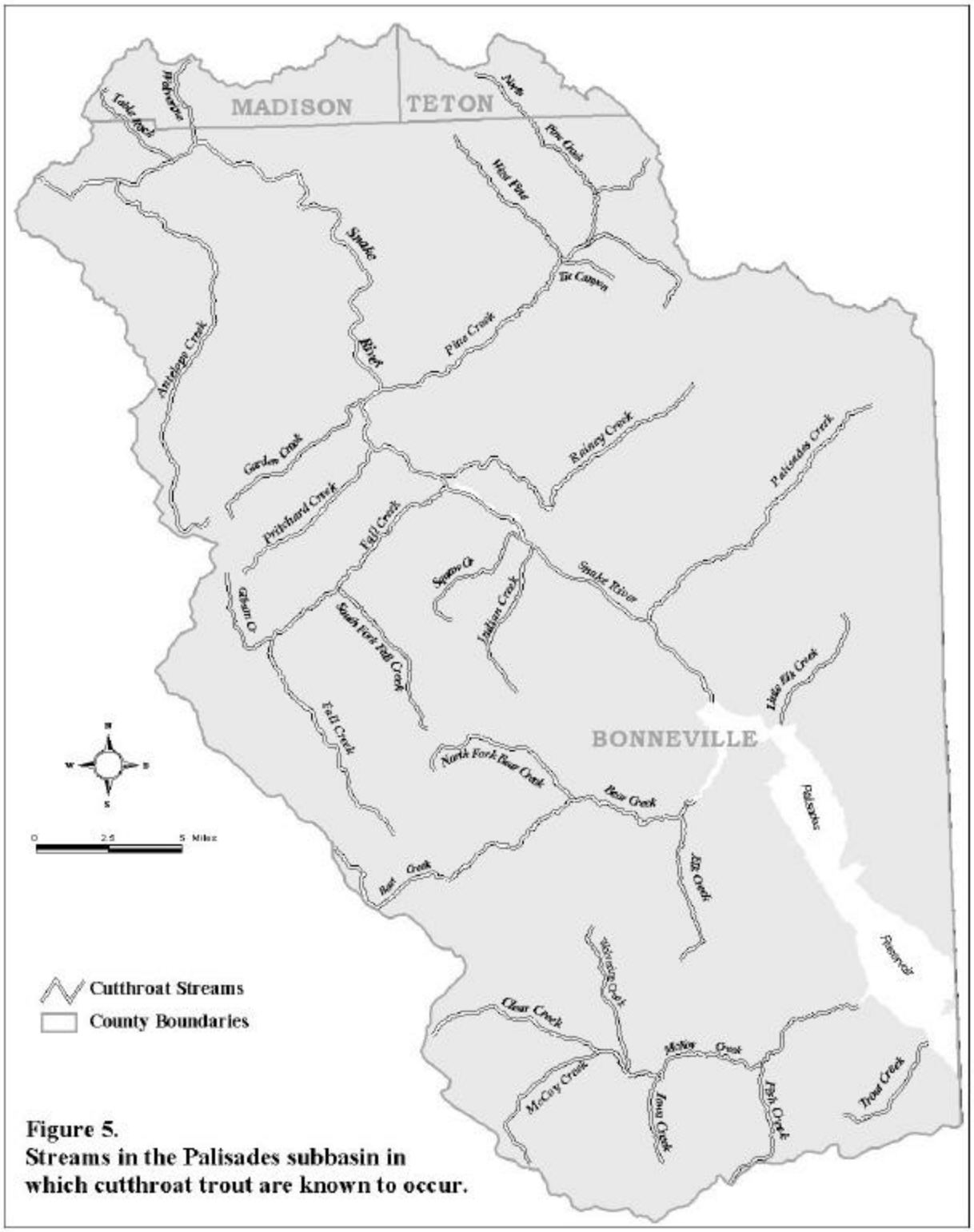


Figure 5.
Streams in the Palisades subbasin in which cutthroat trout are known to occur.

Land Ownership and Land Use

Public lands cover over two-thirds of the land area in the Palisades subbasin (**Figure 6**, Idaho Water Resource Board 1992). Targhee National Forest has historically managed forestlands north of the river and Caribou National Forest is south of the river. During the year 2000, these forests are combining into the Caribou-Targhee National Forest. The BLM and the US Bureau of Reclamation are the other federal agencies that control land in this watershed. Only a small proportion of the land is under state endowment (Idaho Department of Commerce 2000).

The US Bureau of Reclamation manages operation of the dam and one boat launch campground, but Targhee National Forest administers most of the developed recreational facilities around the reservoir. Private residential lands are on the north side tributaries to the reservoir. From the dam downstream to Conant Valley, the south side of the river is mainly national forest land with associated recreational facilities. Some BLM parcels are north of the river, but private land with farms and pastures becomes increasingly common in this vicinity. From Conant Valley to Heise, the canyonlands bordering the river are still mainly Forest Service and BLM lands, but there are a few private parcels. In the flats above the canyon, most of the land is privately owned (Idaho Water Resource Board 1996). There are 39 islands totaling 770 acres in the South Fork between the towns of Swan Valley and Heise. The larger islands are covered with cottonwood stands and the smaller islands have more shrubby trees and other dense riparian vegetation. All of them are public lands in federal ownership, but 25 of them are under special management by the Bureau of Reclamation for power sites and reclamation projects (BLM 1988).

Land use is highly correlated with ownership (**Figure 7**, Idaho Water Resource Board 1990). Forests and rangelands are mainly used for livestock grazing and wildlife habitat. Near the reservoir and along the river, private lands are mainly used for residential purposes, especially for recreational cabins. Further downstream, private land is used more often for crop and pasture production. Irrigated croplands are found throughout Swan Valley and Conant Valley. Beginning at parts of Pine Creek Bench and further downstream to Antelope Flat, dryland agriculture is practiced (TNF 1997a).

In addition to agricultural activities, recreation drives the character of the area due to the large proportion of forestland, the presence of Palisades Dam, and the high quality fishing in the South Fork Snake River. The forests make provision for a range of recreational opportunities from roads and trails for motorized use to primitive backcountry experiences. Some of the steep mountain ranges are inventoried roadless areas, including Bear Creek, Garns Mountain and Palisades Roadless Areas. A portion of the Palisades Roadless Area has been recommended for wilderness designation. Winter sports are also increasing in forest areas such as Kelly Canyon Nordic Ski trails (TNF 1997a). Water sports are a primary attraction at Palisades Reservoir. With about 70 miles of shoreline, six access roads, and multiple campgrounds, picnic areas and boat ramps, the reservoir is a big draw to tourism. The river corridor from Palisades Dam to the Heise gaging station shows heaviest recreational use from May to November, which correlates with the fishing season on this stretch. The South Fork has a national reputation for its native cutthroat trout fishery (Idaho Water Resource Board 1996).

Almost the entire Palisades subbasin is located in Bonneville County, with small portions of Madison and Teton counties included to the north. Irwin (population 125) and Swan Valley (population 155) are the only two incorporated towns in the subbasin. Demographics describing population distribution and trends for Bonneville County are not applicable since Palisades subbasin is so sparsely populated. Most of the private land is rural and unincorporated, some owned by people living in Idaho Falls and Ririe. Many residences on private land are secondary residences used for recreation instead of year-round occupation. Some commercial activity occurs in Swan Valley and Irwin along Highway 26, which is a popular travel route to Jackson Hole and Yellowstone National Park (Idaho Department of Commerce 2000).

Local organizations and cooperative efforts are highly involved in water quality issues. The South Fork Watershed Advisory Group (WAG), headquartered in Ririe, represents some interests affected by management of the watershed. The East Side Soil and Water Conservation District, formed in July 1948 in response severe erosion threats to fertile farmland, helps farmers to install conservation measures and improve water quality. The West Side Soil and Water Conservation District formed in August 1944 under similar circumstances and manages programs for lands west of the South Fork. Both Soil and Water Conservation Districts are administered from the same office in Idaho Falls. Cooperation among federal agencies streamlines efforts to improve water quality, demonstrated by the 1981 Memorandum of Understanding developed by the USBR, BLM, USFS, IDFG, and the US Fish and Wildlife Service to manage the South Fork between Fall Creek and Heise. The BLM and USFS further coordinate land

management according to the 1990 Snake River Activities/Operations Plan for the South Fork corridor (East Side Soil and Water Conservation District 1989).

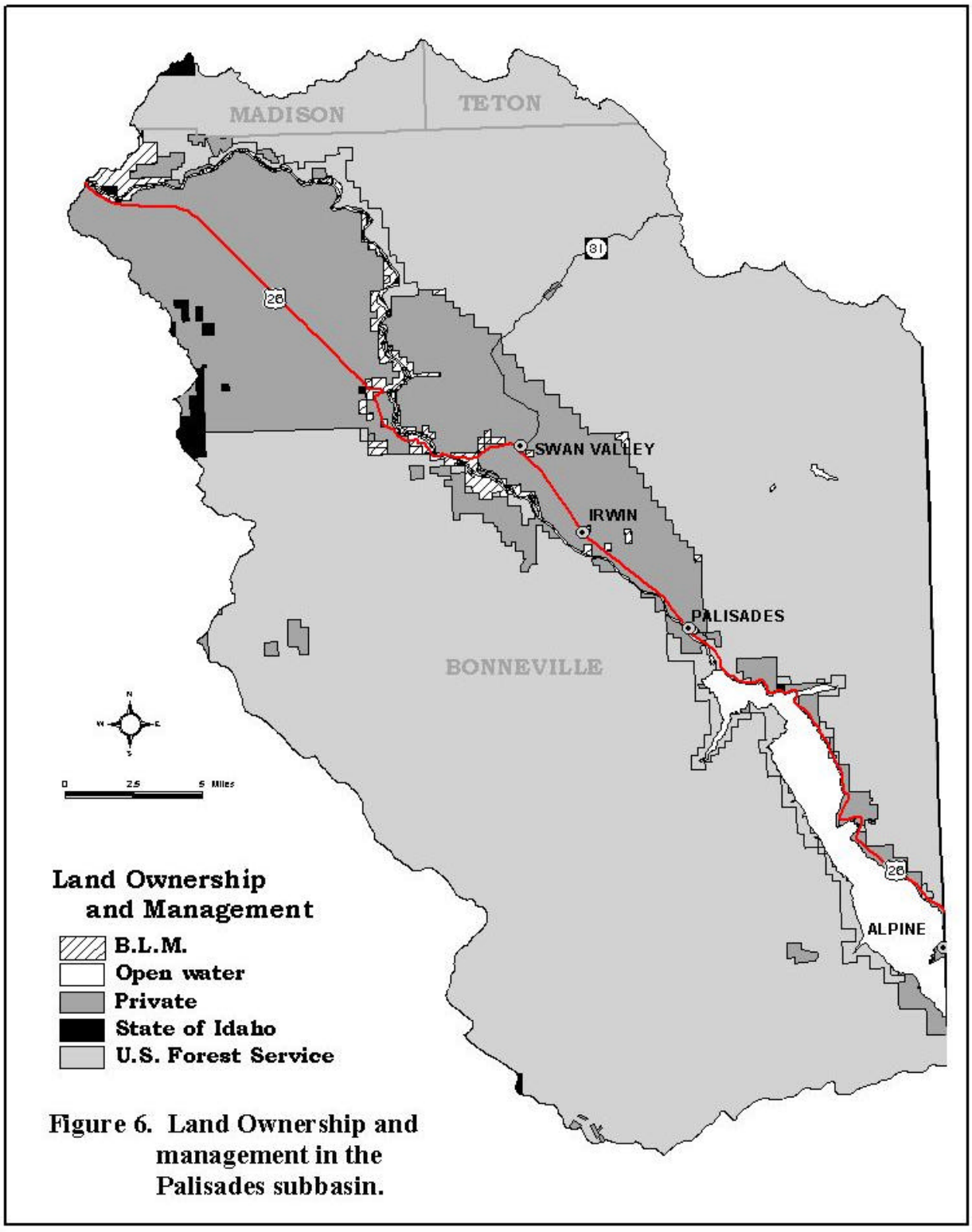


Figure 6. Land Ownership and management in the Palisades subbasin.

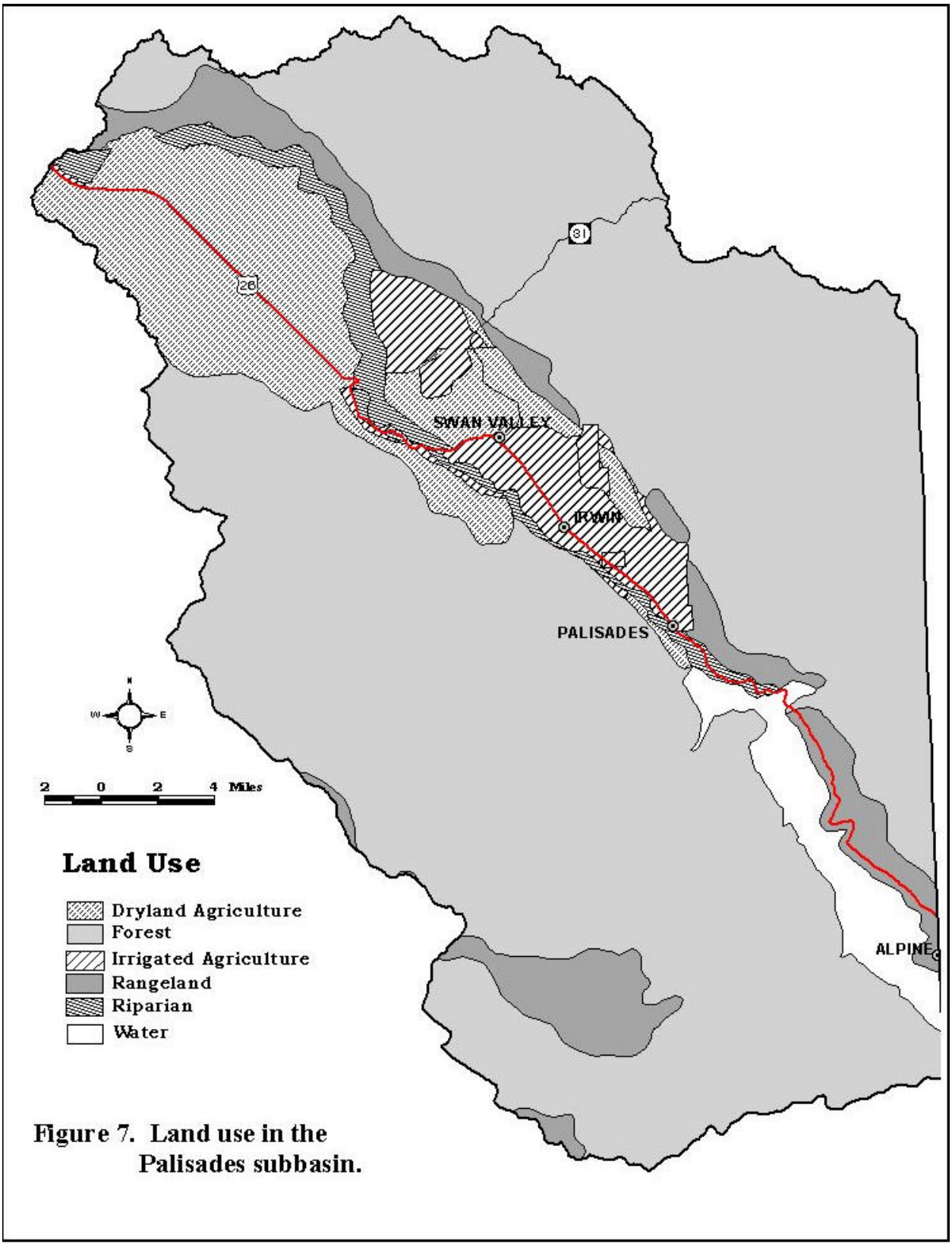


Figure 7. Land use in the Palisades subbasin.